Parental care

Why is parental care more often maternal than paternal?

Female cost vs. benefit:

Females have already invested so much energy in making eggs.

Females are sure of their genes will pass on.

Offspring survival

Male cost vs. benefit:

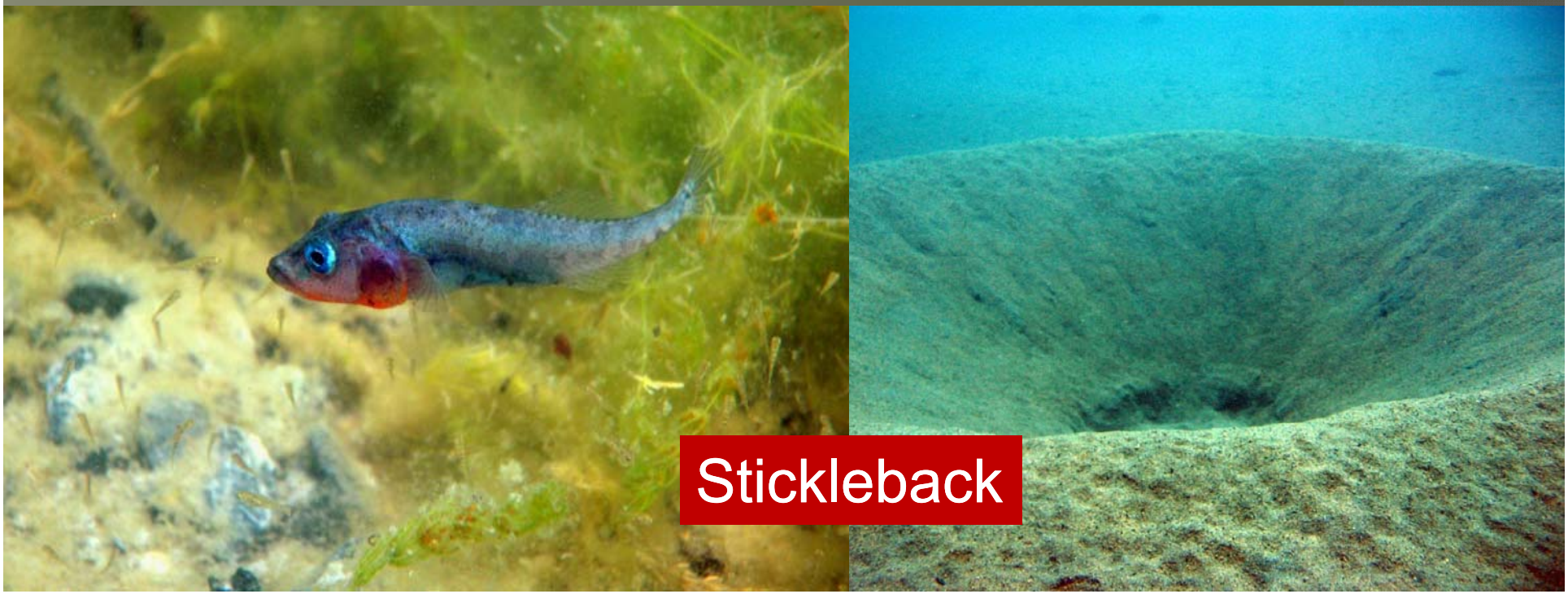
Males tend to mate as many mates as possible, invest more energy on attracting females

Males are not sure if their genes will pass on.

Offspring survival

Male fishes are unusual that they often provide uni-parental care:

Why?



Male fishes are unusual that they often provide uni-parental care: Why?

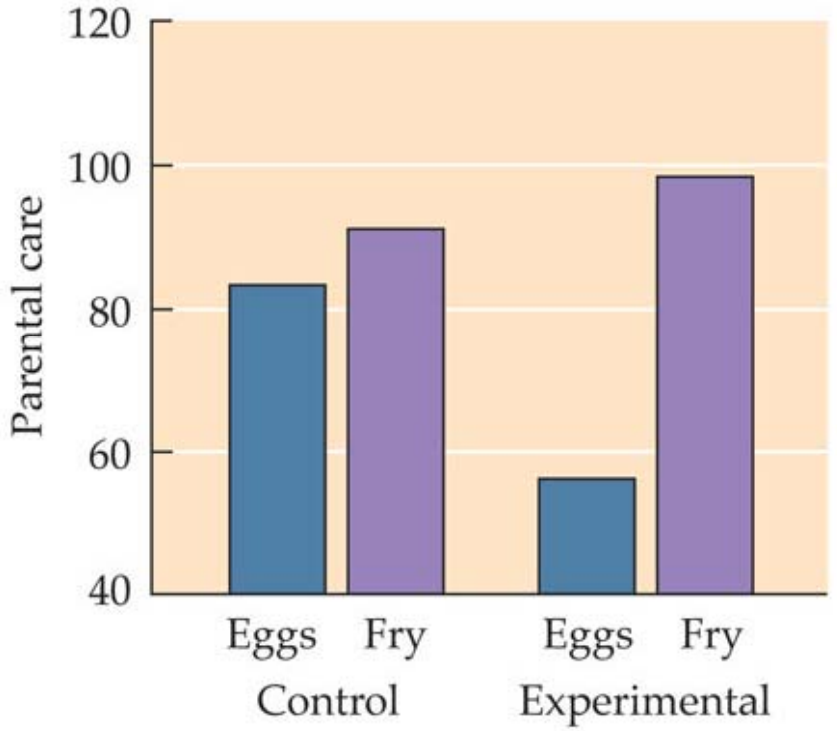
Randall's Jawfish

Stickleback

Paternal behavior might evolve when males can ensure paternity

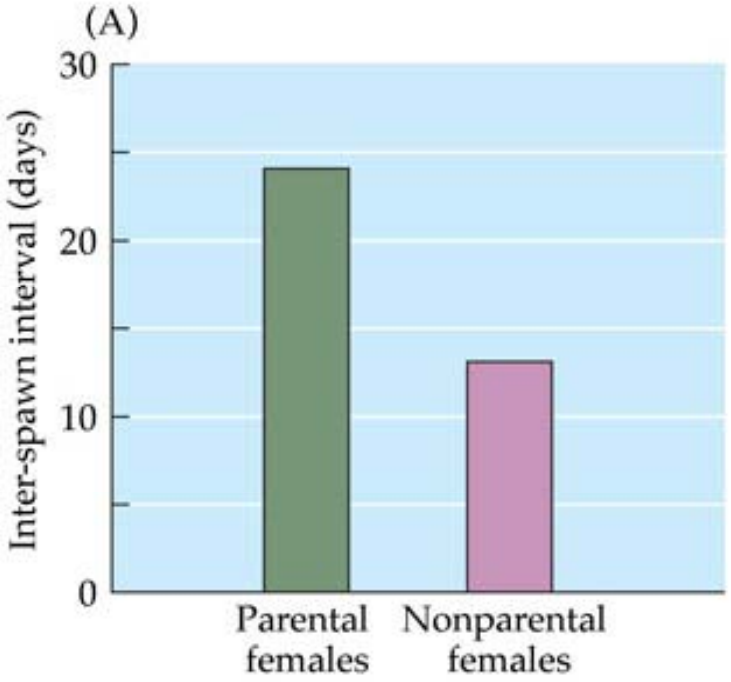
Hypothesis: Males are more likely to take care of young if they "think" they're the dad

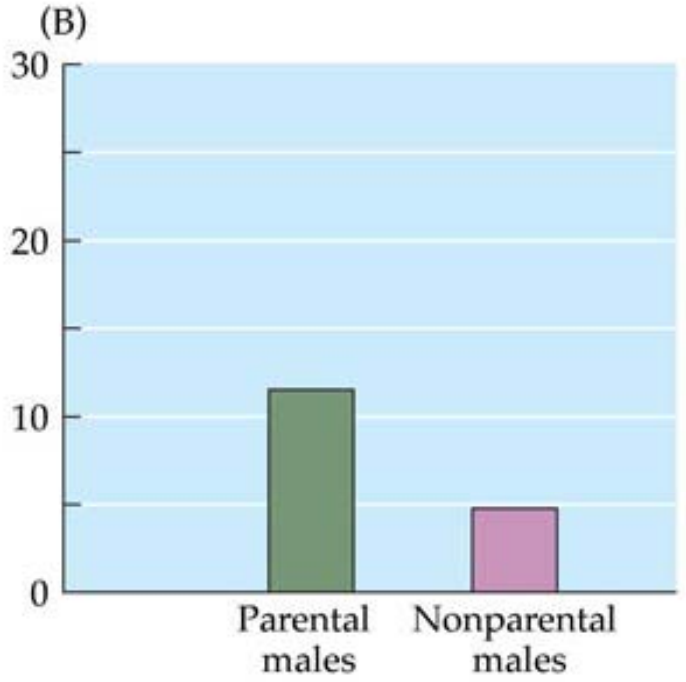
Bluegill



Paternal behavior might evolve when costs are lower for males than for females

St. Peter's fish






THE EVOLUTION OF DAD
PROJECT

To care for their young, parents must recognize their young

Many colonial species are good at offspring recognition

Mexican free-tailed bats

Pregnant females form colonies in the millions…

~4000 pups per square meters

Can mother bats nurse discriminately?

Parent-offspring recognition

Parents should avoid caring young that are not their own offspring.

Can parents always identify their own progeny?

Offspring recognition: function to prevent misdirected parental care.

Prediction: Parents should be especially good at identifying their own young in colonial species, but not as well in solitary species.

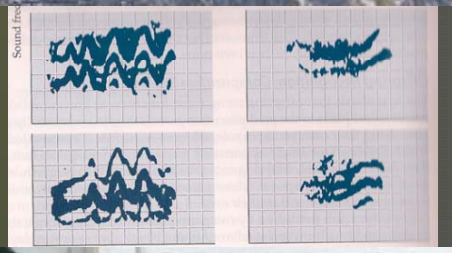
Bank swallows and rough-winged swallows

Bank swallows: colonial species, fledglings have distinctive begging calls

Rough-winged swallows: solitary species: fledglings have, less distinctive begging calls

Cliff swallows and barn swallows

Cliff swallows: colonial species;
- nestlings have distinctive,
- highly variable begging calls
- Parents recognize their young.

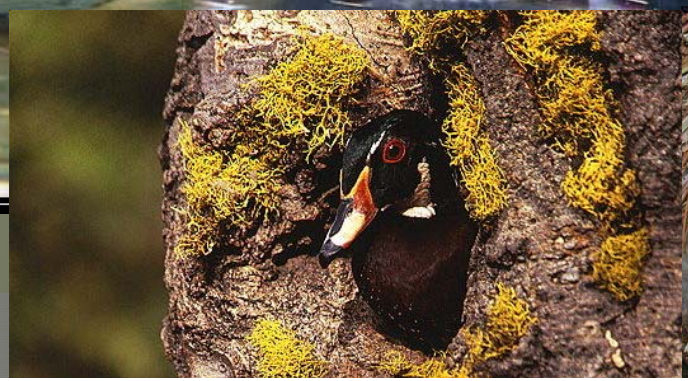


Barn swallows: solitary species
- fledglings have less distinctive calls
- Parents do not recognize the young

When parents fail to recognize offspring: Some take advantage of it…..

Intra-specific Brood parasitism

Wood duck (egg-dumping)



When parents fail to recognize offspring: Some take advantage of it…..

Inter-specific brood-parasitism

European cuckoos

Inter-specific brood parasitism

Brown-headed cowbirds (216 host species)

Host parents fail to recognize parasitic cowbird young

Parasitic cowbirds lay eggs in other species' nest

Parasitize > 200 species






Parasitic cowbirds lay eggs in other species' nest

(altricial nestlings)

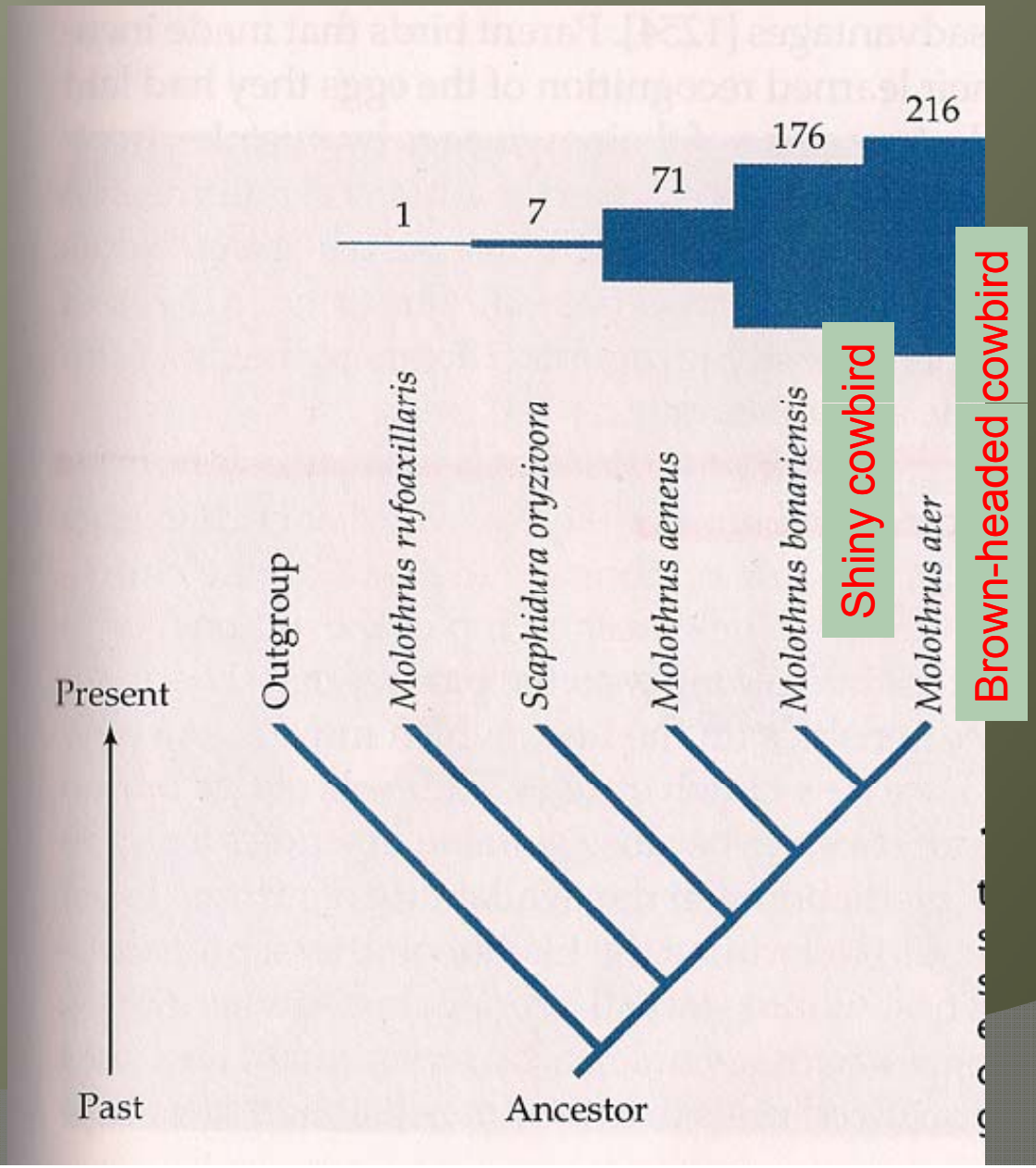





Interspecific brood parasitism

Brood parasitism in Shiny cowbirds (176 host species) of South America

How has brood parasitism evolved at the first place?



Phylogeny (family history) of Cowbirds

Studying phylogeny can help us better understand the origin and evolution of behavior

What exactly do parents provide?

Food,

Home,

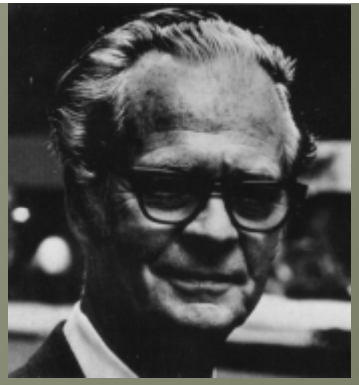
Protection (from predator)

Skills to survive (tool-making, foraging)

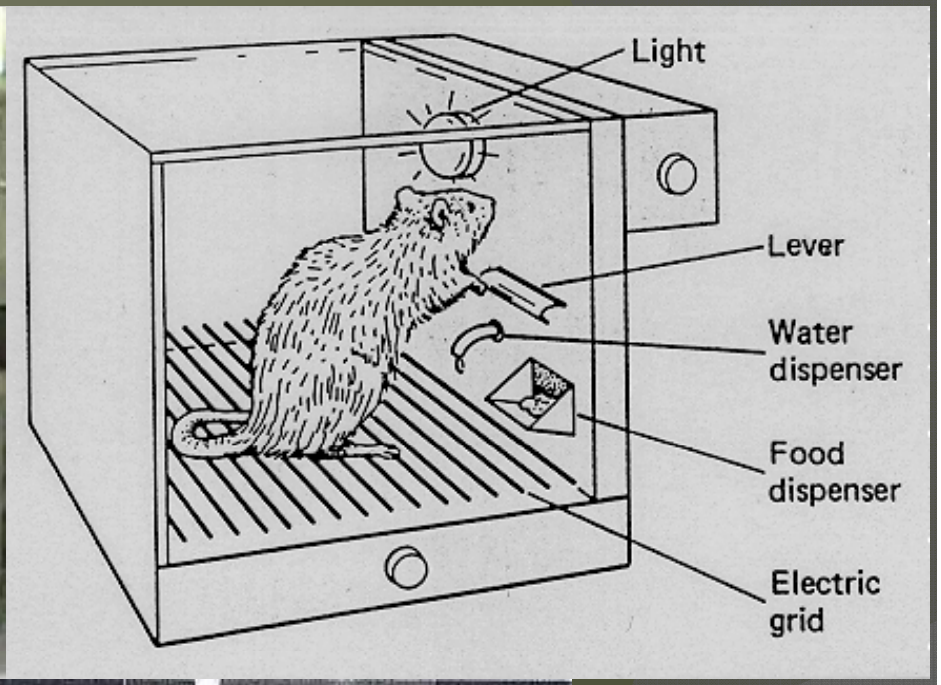
Love??

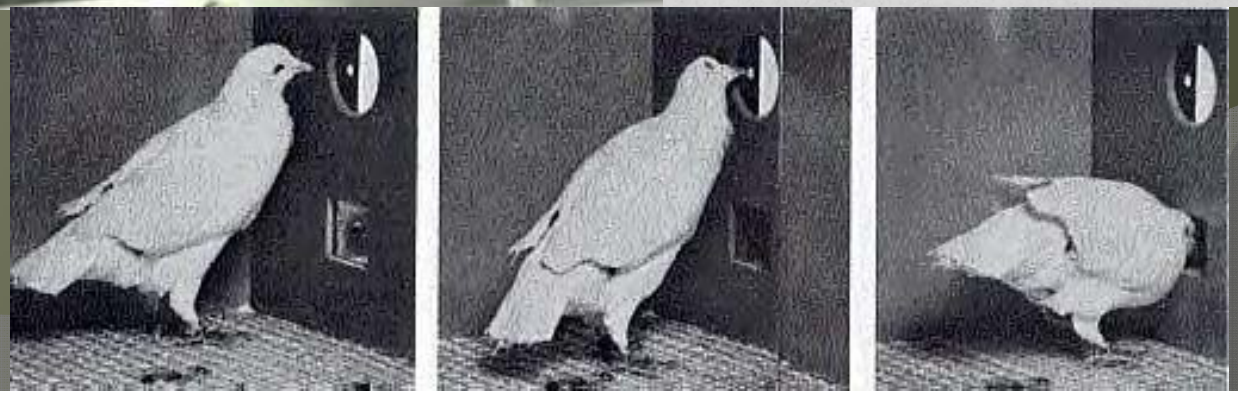
In operant conditioning:

Behaviors can be trained (learned) by providing reward or punishment, so is teaching (caring) offspring?



Skinner Box





Skinner Box for humans?

.

Can operant conditioning apply to parental care?

Is love or attachment really important?

Harry Harlow
~1950s

Infant attachment
for mother

~ according to Skinner,
infants clung to mom
because of food reward

Harry Harlow's experiment I:

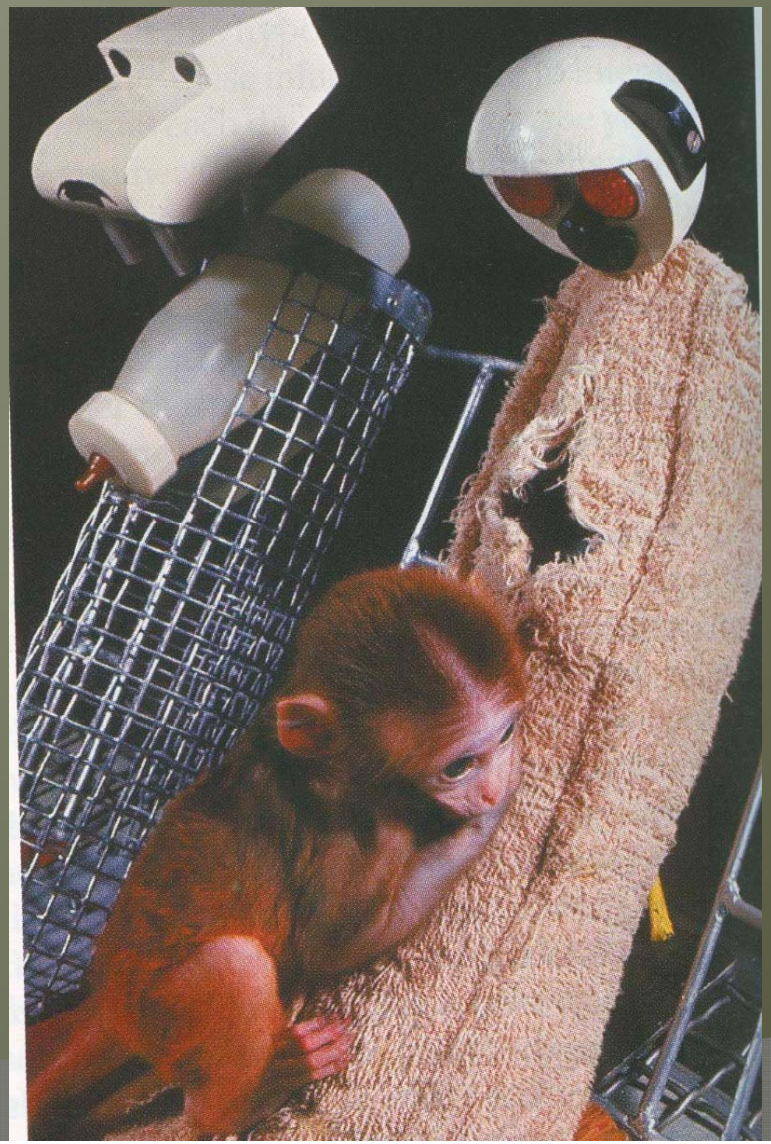
*www.**youtube**.com/watch?v=KlfOecrr6kI*

Harry Harlow's experiment II: fear response

http://www.youtube.com/watch?v=fg9QCeA4FJs&feature=related

As these experimental monkeys grew up: depression
stressed
socially awkward

What is missing here?
(what else mom can provide)



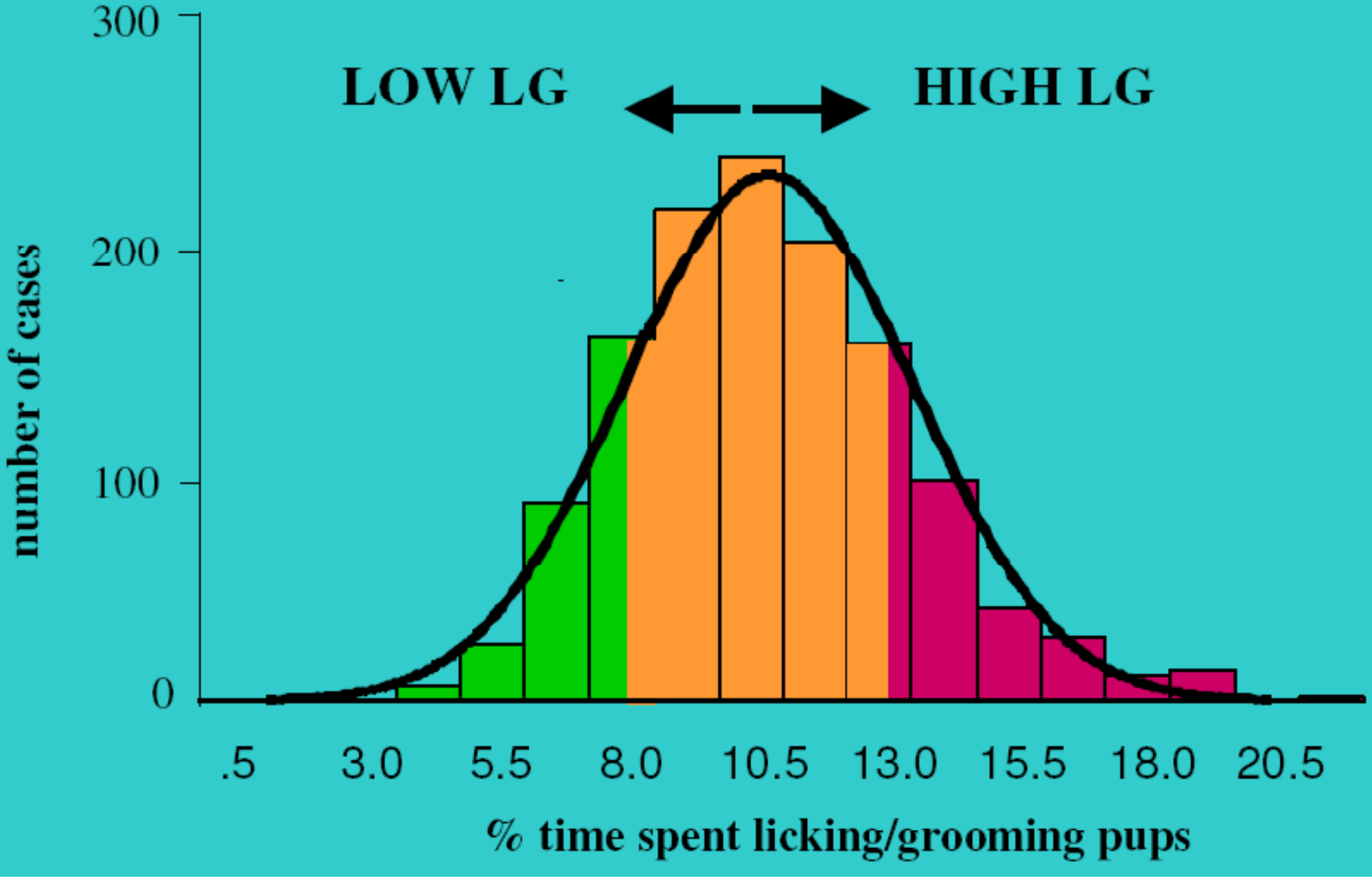


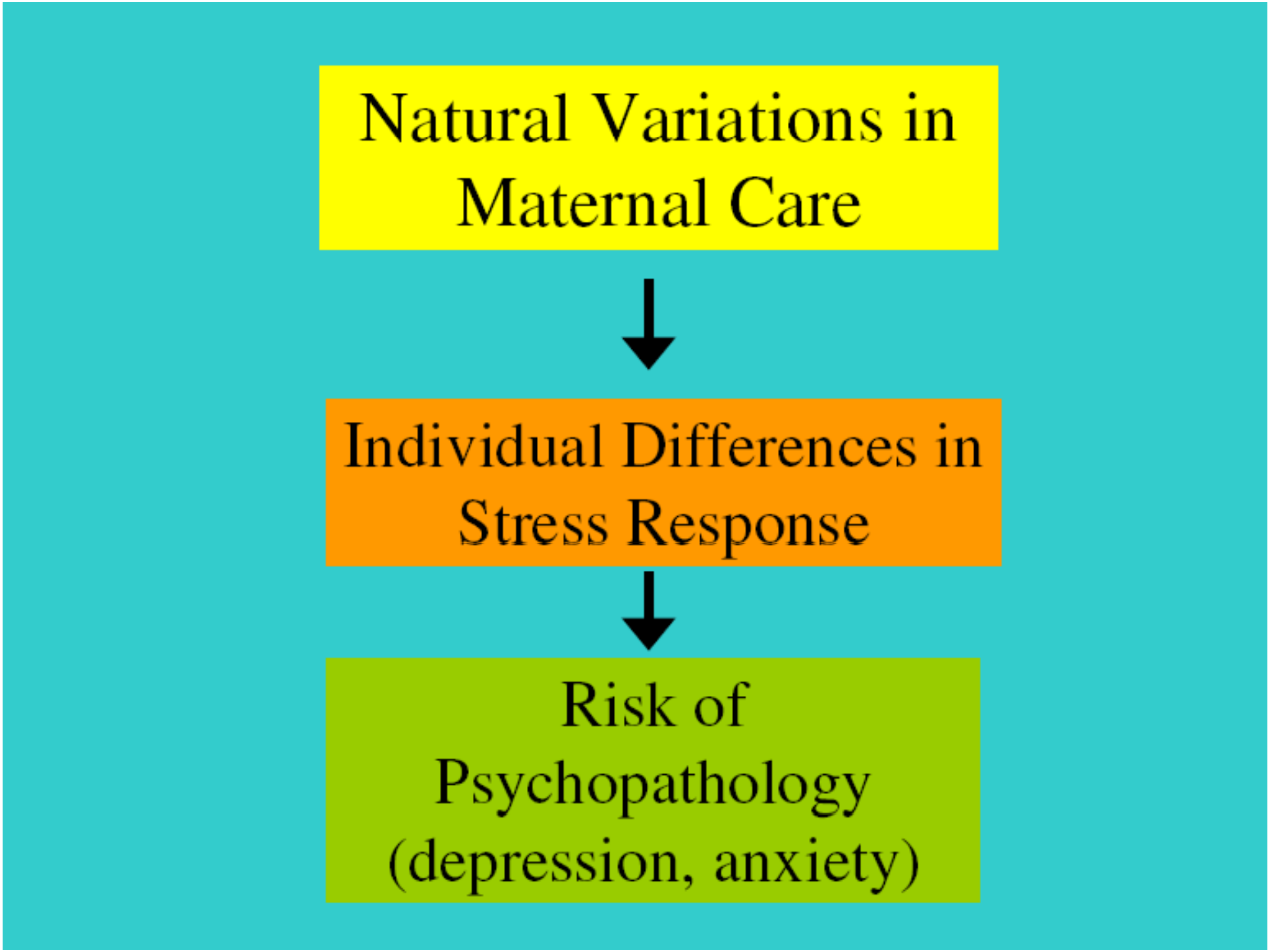



Rats:

Mom: licking and grooming the pups

Frequency Distribution of Maternal Licking & Grooming of Dams (cummulative)




Natural Variations in Maternal Care
Individual Differences in Stress Response
Risk of Psychopathology (depression, anxiety)

High licking/grooming (LG) mom
have more GR (Glucocorticoid receptor)
and more SR (Serotonin receptor) in their brain.

-- Glucocorticoid is a stress hormone, binds to glucocorticoid receptor.
-- Serotonin is a “police” hormone (neurotransmitter) regulate mood, depression….

-- More GR and SR, better stress response.

-- High LG mom/infants have more GR/ SR in the brain.
-- Low LG mom/ infants have less GR/ SR in the brain.
-- Same gene but produce different amount of protein.

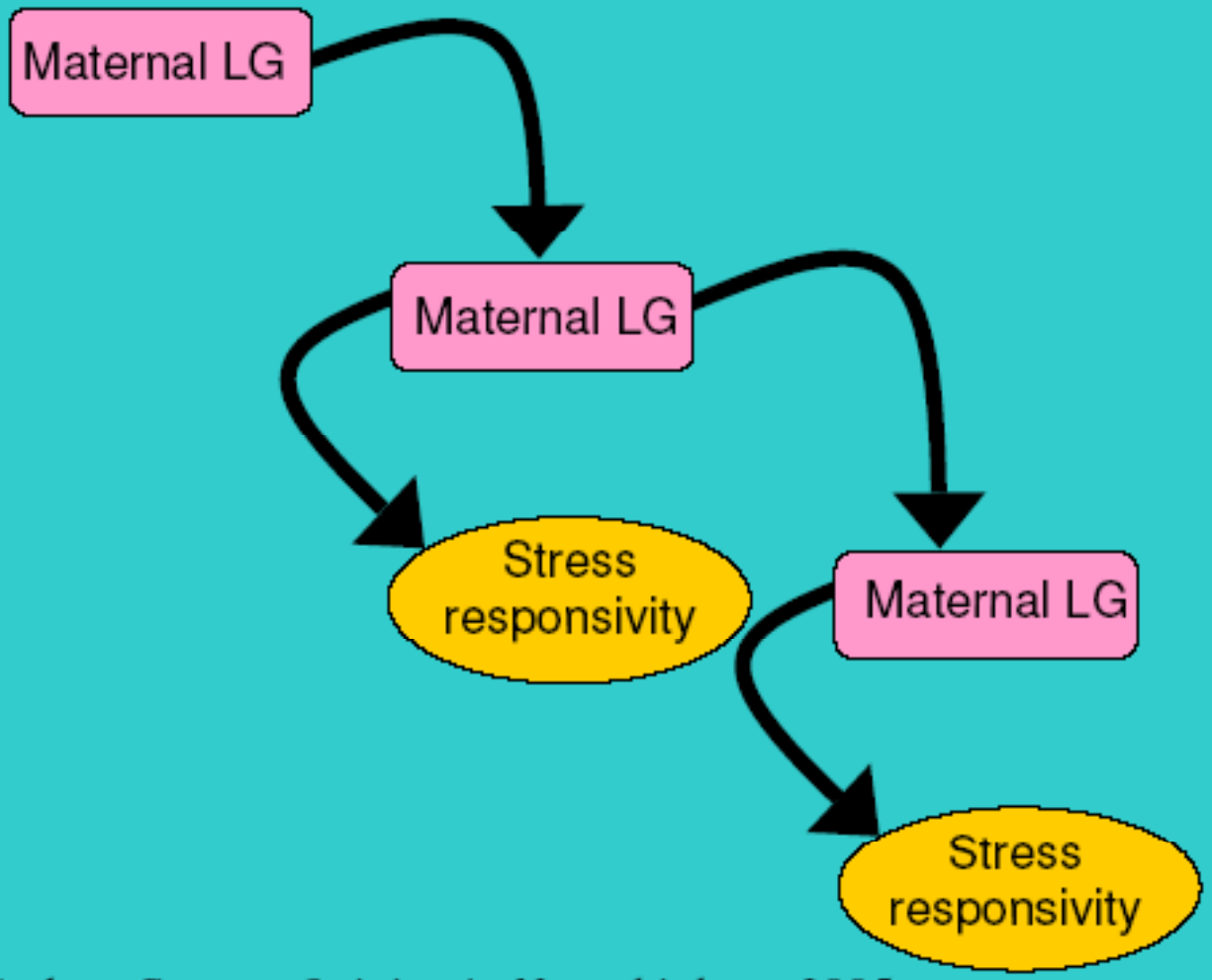
Cross-fostering experiment

-- High LG mom foster pups from low LG family pups develop more GR/ SR in the brain.

-- Low LG mom foster parent pups from high LG family pups develop less GR/ SR in the brain.

-- Same gene but express different amount of protein.

Transmission of maternal care and stress responsivity across generations



Champagne & Curley, *Current Opinion in Neurobiology*, 2005

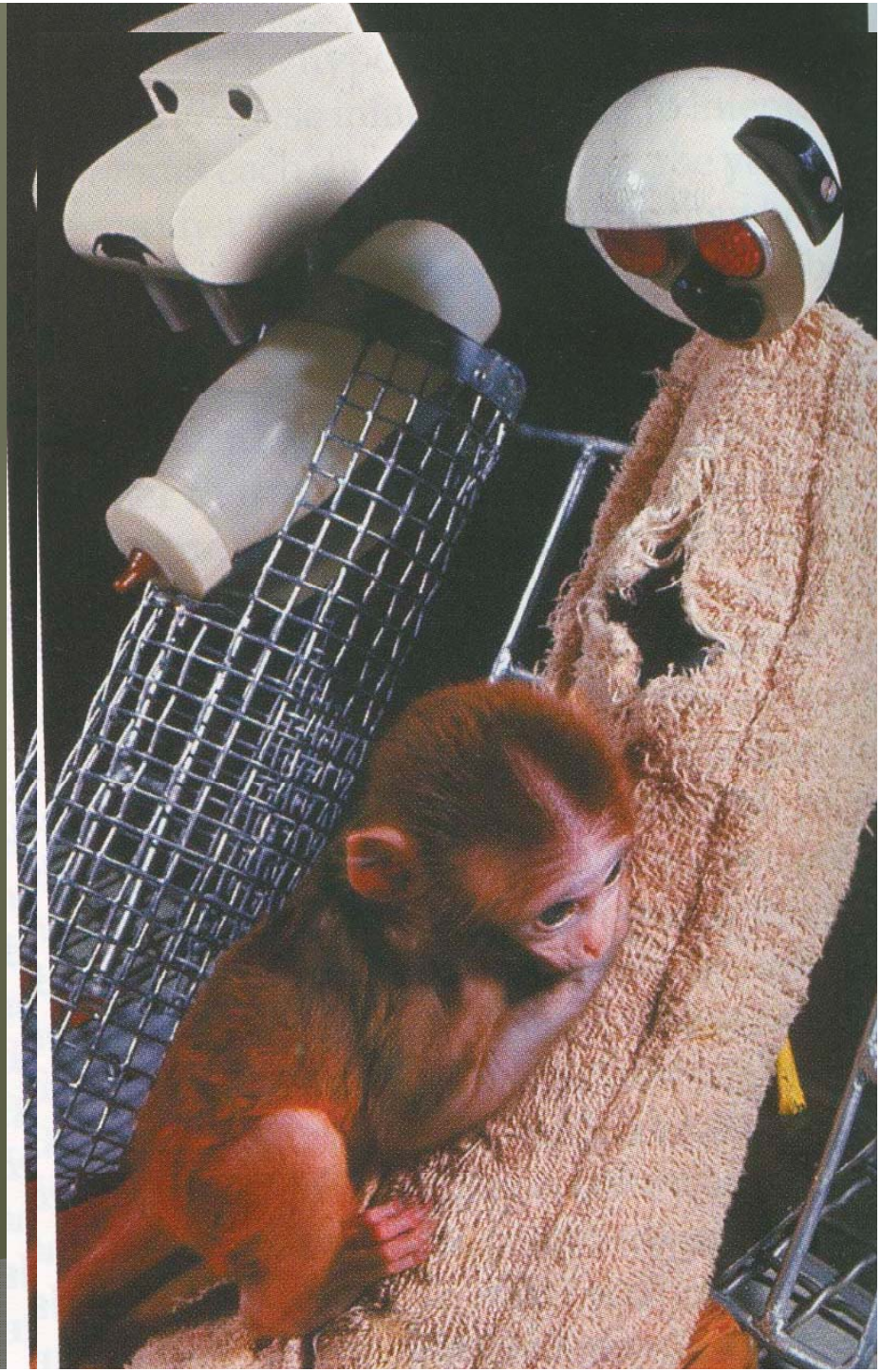
What happened when these monkeys became mothers? (motherless mothers)

-- neglectful
-- abusive

toward their own infants
over generations

Neglect begets neglect.

Abuse begets abuse



How does neglect beget neglect?
How does abuse beget abuse?

How does an event occurring so early in life have a long-term impact on behavior?

Epigenetic modifications to DNA

What is epigenetics?

Heritable changes in gene expression caused by mechanisms other than changes in the underlying DNA sequence.

Examples of such changes might be DNA methylation or histone modification, both of which serve to suppress gene expression without altering the sequence of the silenced genes.

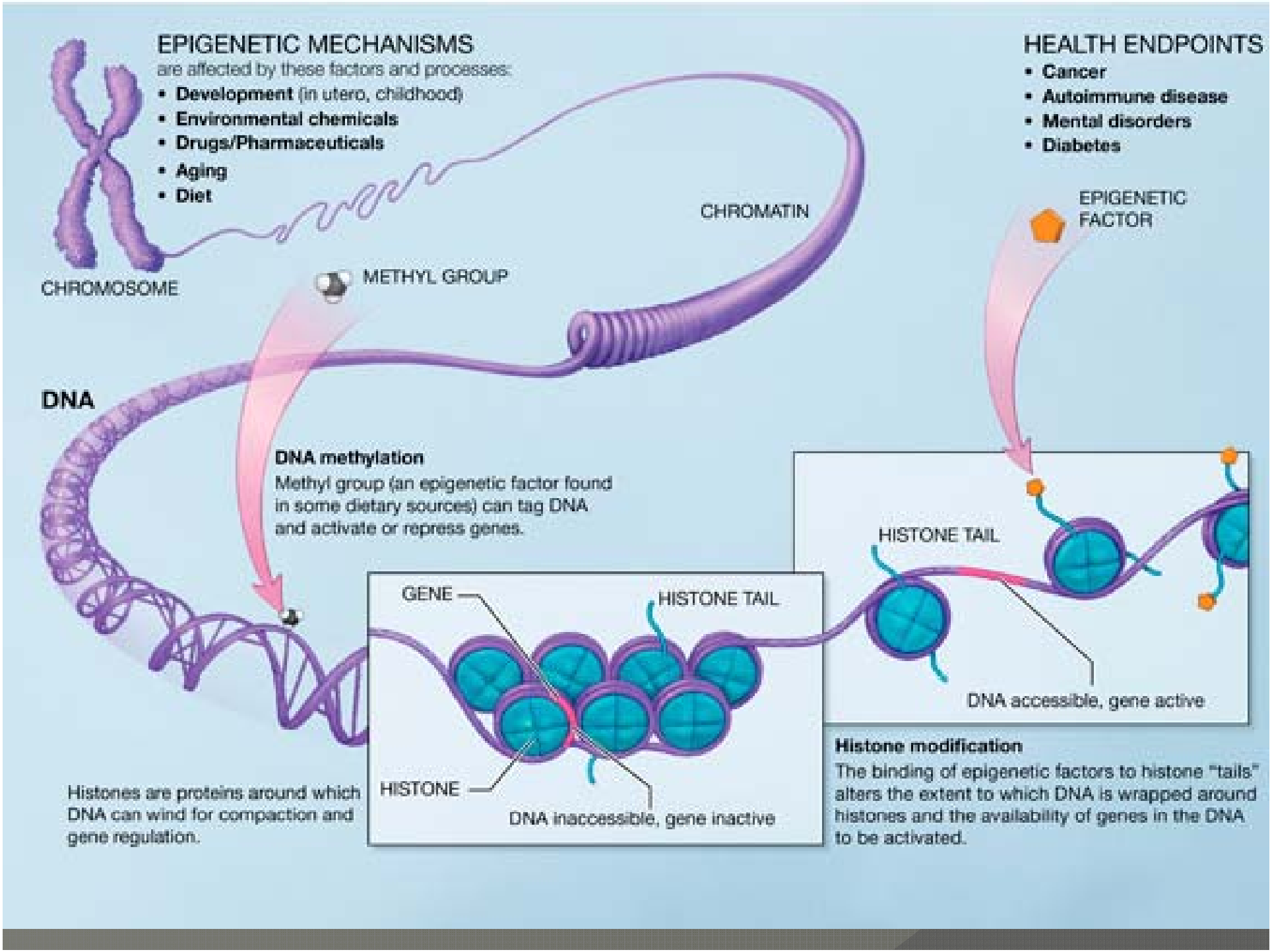
DNA contains 2 sources of information:

1)The DNA sequence (CATTGGATTCCGGA) → Generates proteins

GENOME

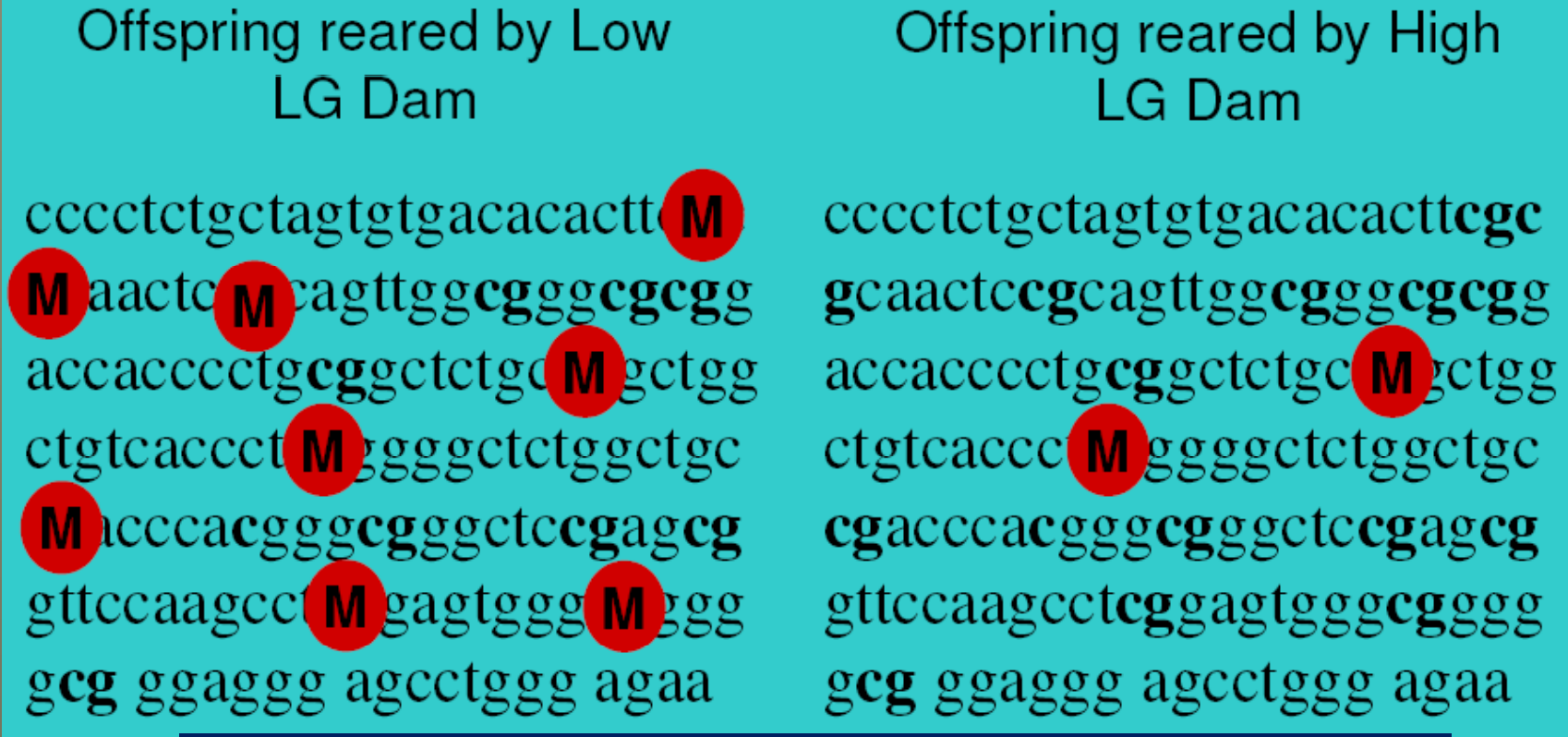
2) The structure of DNA → Serves as an "on/off" switch for gene expression

EPIGENOME


EPIGENETIC MECHANISMS
are affected by these factors and processes:
• Development (in utero, childhood)
• Environmental chemicals
• Drugs/Pharmaceuticals
• Aging
• Diet
HEALTH ENDPOINTS
• Cancer
• Autoimmune disease
• Mental disorders
• Diabetes
CHROMOSOME
CHROMATIN
METHYL GROUP
EPIGENETIC FACTOR
DNA
DNA methylation
Methyl group (an epigenetic factor found in some dietary sources) can tag DNA and activate or repress genes.
GENE
HISTONE TAIL
HISTONE
DNA inaccessible, gene inactive
HISTONE TAIL
DNA accessible, gene active
Histones are proteins around which DNA can wind for compaction and gene regulation.
Histone modification
The binding of epigenetic factors to histone "tails" alters the extent to which DNA is wrapped around histones and the availability of genes in the DNA to be activated.

Epigenetic modification of DNA

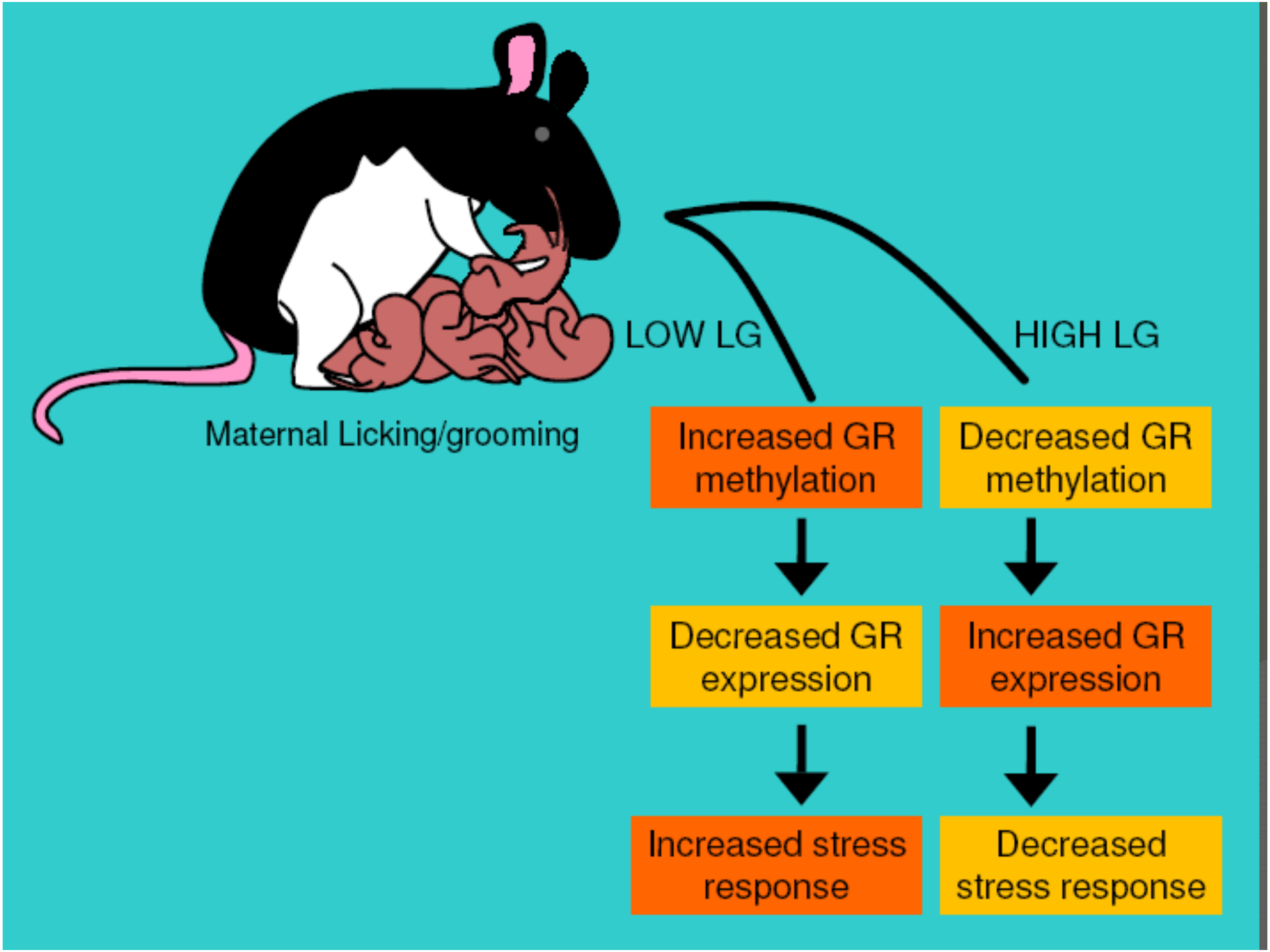
GR Methylation in Response to Rearing Environment



Same DNA sequence, but different extent of methylation

Low LG/ high LG moms have the same GR gene (DNA sequence), the difference is the methylation of GR gene → high LG pups express and produce more GR→ better stress response.

Epigenetic regulation of gene -- methylation/ demethylation of genes regulate protein production


LOW LG
HIGH LG
Maternal Licking/grooming
Increased GR methylation
Decreased GR methylation
Decreased GR expression
Increased GR expression
Increased stress response
Decreased stress response

Nat Neurosci. 2009 March ; 12(3): 342–348. doi:10.1038/nn.2270.

Epigenetic regulation of the glucocorticoid receptor in human brain associates with childhood abuse

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Abstract

Maternal care influences hypothalamic-pituitary-adrenal (HPA) function in the rat through epigenetic programming of glucocorticoid receptor expression. In humans, childhood abuse alters HPA stress responses and increases the risk of suicide. We examined epigenetic differences in a neuron-specific glucocorticoid receptor (*NR3C1*) promoter between postmortem hippocampus obtained from suicide victims with a history of childhood abuse and those from either suicide victims with no childhood abuse or controls. We found decreased levels of glucocorticoid receptor mRNA, as well as mRNA transcripts bearing the glucocorticoid receptor 1_F splice variant and increased cytosine methylation of an *NR3C1* promoter. Patch-methylated *NR3C1* promoter constructs that mimicked the methylation state in samples from abused suicide victims showed decreased NGFI-A transcription factor binding and NGFI-A–inducible gene transcription. These findings translate previous results from rat to humans and suggest a common effect of parental care on the epigenetic regulation of hippocampal glucocorticoid receptor expression.

There are maternal effects on the development of individual differences in behavioral and HPA

Parent-offspring conflicts

Parents: care as many healthy offspring as possible: lifetime investment.

Strategies: a few well-fed offspring or many less healthy offspring?

Parent – offspring conflicts

Offspring:

Strategy:

maximize each individual's needs,
at the cost of parents or/ and
other siblings' survival.

Parent-offspring conflicts between fetuses and mom

Gestational diabetes…
(what is the cause?)

Parent-offspring conflicts between nestlings and parents

Food begging call is a manipulative tool

Parent-offspring conflicts between infants and parents

Crying is a manipulative tool

Parent-offspring conflicts

Infanticide

- Common in animals

Parent-offspring conflicts

Infanticide

killed by males

Understand species-specific natural history is essential to understand the evolution of animal behavior

Parent-offspring conflicts

Infanticide

killed by females

Polyandrous jacanas

Why infanticide?

1. Sexual selection hypothesis,

   infanticidal males will gain a reproductive advantage provided that only unrelated infants are killed and that the males increase their chances of siring the next infants.

2. Social pathology hypothesis,

   infanticide as a result of crowded living conditions and not providing any advantage.

How to test it?

Why infanticide?

Force females : sexually receptive

Dominant males have short time-window to control the pride (group).

Females give birth every 1-2 years.

A cost to females, benefit to males

Parent-offspring conflicts

Infanticide in humans, why?

Sibling rivalry

each sibling wants to get the most benefit

Sibling rivalry

Siblicide

In Egrets, Black eagles
Sibling competition,
First hatch kills late hatching

- Hatchling has higher level of testosterone

Sibling rivalry

Siblicide

Siblicide in Booby

Why?

1. Fertility
2. Food abundance

Sibling rivalry

Siblicide

In Spotted hyena,
First one kills the second pup

Sibling rivalry in humans

King Lear --Shakespeare

Parent-offspring conflicts

vs. Mating systems

Genetically monogamous species: Less conflict

Polygamous species: More conflict, competition